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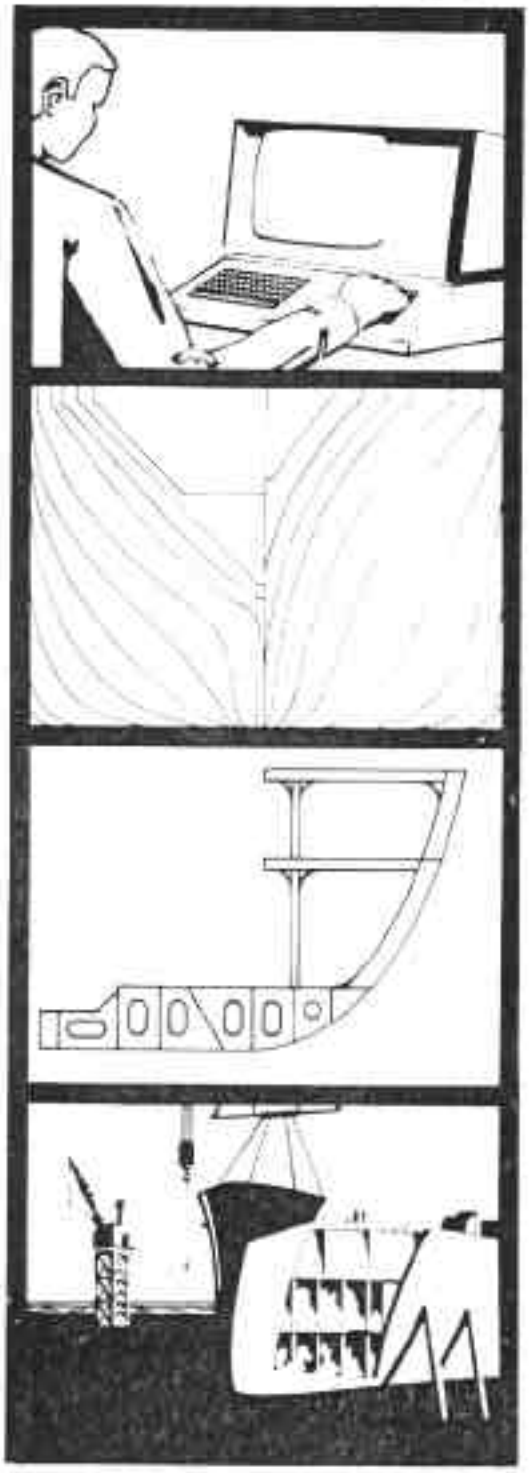

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GROUP TECHNOLOGY AND AUTOMATED PROCESS PLANNING, A CHANGE IN MANAGEMENT STRATEGY

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ABSTRACT

The trend toward increased customization is increasing the problems associated with batch manufacturing, both in design and manufacturing itself. Group technology helps to solve these problems and is thus attracting great interest. The benefits of group technology in such applications as design retrieval, design standardization, standardization of machine tool routings, automated process planning, and machine tool investment can bring about dramatic savings in the multi-billion dollar manufacturing industry.

INTRODUCTION

Three or four years ago, only a handful of companies were interested in group technology. Today, many companies, including a number considered to be highly conservative, are seriously considering or have adopted group technology systems.

This increased interest is a reflection of a growing awareness of the potential benefits of group technology, particularly for batch manufacturing.

These advantages can apply to both design and manufacturing.

What is Group Technology?

Group Technology is an approach to finding common solutions for the same or similar problems. It is a means of helping designers to find the best possible design solutions quickly, and of helping manufacturing engineers to solve industrial engineering problems optimally. It provides consistent solutions to current problems, based on experience. It does this in part through an identification method which classifies and codes design and manufacturing characteristics of parts and by then making design and manufacturing solutions based on these attributes available for future use.

Trends Toward Customization

In recent years there has been a growing demand for more customized products. There are several reasons for this:

- sharper competition and new approaches to marketing have led to multiplicity of special features and options, often on products which once had little variation;
- increasing energy costs have spurred interest in alternative ways of doing things, and thus in more customized product requirements.
- new materials have encouraged exploration of new product variations:
- OSHA regulations have made many changes and variations necessary;
- increased durability demands have been "brought on by skyrocketing maintenance costs and have resulted in more stringent product requirements.

Design Implications

All of these influences have led to more and more special designs, which, of course, mean many nonstandard parts. As the number of different parts increases, batch sizes grow smaller. With smaller batch sizes, design costs per unit become higher.

Parallel with all of this is the traditional lack of communication between design and manufacturing operations. There is little feedback to the designer about the impact of design decisions on manufacturing costs. A minor design change can add a great deal to manufacturing costs; when designers do not understand the ramifications of their decisions, costs are bound to increase.

Day-to-Day Design Problems

The increasing demand for customized products has a daily impact on designers.

When a request for a new part comes into the design department, the designer is faced with several immediate questions. Among them are:

- Is it a new part?
- Have we made it before?
- Have we made a similar part before?

Conventional design retrieval systems are often inadequate to provide the needed answers. A search. of the files may require hours and still lead to nothing. More sophisticated

questions, such as those relating to potential manufacturing costs, are even more difficult to answer.

Rather than struggle with-the inadequate information system, designers will most often save time and frustration by simply creating a new design.

In a significant portion of the cases, a design for the part, or something quite similar, will already be in the files. Thus, the designer *is* "reinventing the wheel". The new design may be slightly different, however - - he may arbitrarily specify a different tolerance, for example.

Unnecessary design proliferation is the result.

Design files grow, and designs become even more difficult to retrieve. There may be 50,000 drawings in the files, and only 5,000 active parts for manufacture.

Group Technology and Design

An effective group technology system can solve these day-to-day problems through its coding and classification applications. Design retrieval is made very simple. Design analysis and standardization become feasible, and new channels of communication can be opened between design and manufacturing,

Coding and classification, especially with a computerized system such as MICLASS, is simple.

The designer begins with a rough sketch of the part. Through a computer terminal, which is hardly more complex than a typewriter, he is asked to describe the characteristics of the part by answering a series of questions. The computer asks specific questions, and the designer responds by typing in "yes" or "no" answers, or dimensions. No special computer training should be required.

To be effective, the group technology system must have a rapid retrieval capability. With such a capability, the designer can immediately find out if the part has never been designed before, whether it has been designed in the past, or if there is a drawing of a similar part already in the files.

The system should also have the computer software required to extract other relevant information from datafiles. cost information, for example, should be available to the designer as well as to manufacturing personnel.

Impact of Group Technology

When we look at the total costs of batch manufacturing operations, it appears that design accounts for only a small portion of these costs - - usually around 15%. The remaining 85% is attributable to manufacturing. Thus, while a comprehensive group technology system can have a very useful impact in design, the potential for major benefits lie in manufacturing. Companies which commit themselves to group technology for design applications only are not really taking advantages of the significant benefits of group technology.

Group Technology Benefits for Manufacturing

A comprehensive computerized group technology system can benefit manufacturing operations in a number of ways:

Retrieval of manufacturing information: A computerized group technology system, such as the MICLASS system, classifies and codes design and manufacturing information. With such information, which includes data on the company's manufacturing capabilities, it is possible to efficiently retrieve and analyze manufacturing information. It is possible to standardize manufacturing process planning and implement automated process planning.

Retrieval of manufacturing costs: Group technology also makes it possible to retrieve manufacturing costs, based on previous experience, and thus reduces the risk in making quotations. In addition, it helps make the designer aware of the manufacturing costs which result from his design decisions.

Grouping of parts: The same or similar parts can be grouped together according to their manufacturing characteristics. The formation of families of parts greatly reduces the number of "unique"' situations with which manufacturing must deal. Instead of 1,000 different parts, for example, there may be 10 groups of 100 similar parts each.

Dedication of machine tools: Not only is it possible to group parts together by their manufacturing characteristics, it is also possible to dedicate groups of machine tools to produce these families of parts; by taking into account lot sizes, releases per year, and machine tool capacities. This does not require-the physical moving of machine tools into groupings, but rather dedicating them to the parts involved.

This grouping of parts into families and dedicating groups of machine tools to produce them, leads to what we might

call a "Door man's way" of mass production-; With the number of variables in a batch manufacturing operation significantly reduced, a number of efficiencies become practical. These. include:

. Reduction in set-up time - - with similar parts coming through each machine all the time, very few,, if any, drastic changes have to be made in, set-ups.

. Reduction' in process planning time - - with the standardization of manufacturing process plans for these, families of parts, and especially with automated process planning, production planning time is significantly reduced. Past experience is utilized to the maximum:

. Reduction in durable tooling - - because machine tools are better utilized by switching to more dedicated tools for families of parts, capacity can be maximized without unnecessary machine tool investments.

. Less scrap - - since families of similar parts flow more or less continuously across groups of dedicated machine tools, machinists are not faced with "new" parts all the time. This leads to more consistent proficiency in production: With increased proficiency, there is less scrap (and lower quality control costs).

. More efficient machine tool use - - the dedication of machine tools to families of parts, and design and manufacturing standardization, mean that machine tools are used much more efficiently than with conventional approaches to batch manufacturing.

. Easier machine tool loading and scheduling with fewer variables- and the power of the computer, scheduling and loading become much less complex and much more efficient.

. Reduction in throughput time - - all of this obviously leads to shorter throughput time, by switching to semi-mass production techniques.

. Lower work in process - -_ as throughput, time decreases, and parts move more quickly and efficiently through the production cycle, the amount of work in process drops accordingly.

Impact on Small Batch Manufacturing

Increased customization has had an even greater impact on manufacturing than on design operations. As product variations increase, lot sizes decrease in size. This has an immediate effect on manufacturing costs and operations.

In addition to more product variations, manufacturing management must also contend with the increasing difficulty in finding competent production personnel, and the growing shortage of capital available for production equipment.

The conventional response to the need for more product variations is to emphasize shop flexibility.

This in turn leads to requirements for more machine tools, which results in high machine tool investment costs per unit produced.

Set-up times and costs increase, reflecting smaller lot sizes and requirements to reset for each lot. Machine tool use grows increasingly inefficient.

Related to this, scheduling and machine loading become more complex as the number and variety of lots grow. In addition, personnel seem to be constantly learning how to make new parts. Scrap rates are high, quality control costs are also high, and personnel are inefficiently used. When we recognize the problems of finding competent personnel, these problems become even more intense.

With small lot sizes, process planning costs per unit increase. The process planner is faced with problems which parallel those of the designer. When a design for a new part is received, the process planner usually has no efficient means of determining whether or not a process plan for the part, or a similar part, already exists. There may be immense files of process plans, but without an efficient and effective retrieval mechanism, past experience is useless to the process planner. As a number of designs proliferate, so do the number of process plans. Process planning costs grow along with all the other costs.

On the shop floor, material handling costs grow steadily, especially with functional shop layouts.

The overall results of all of this are long throughput times, high work in process inventories, and inefficient machine tool use.

All of the above are interrelated in many ways. The basic principle is that, through group technology, mass production efficiencies and economies are well within the realm of possibility.

Machine tool purchases: The analysis applications inherent in group technology systems make it possible to determine machine too1 needs much more accurately than with conventional methods. As a result, decisions on machine tool purchases can be made with an understanding of their potential ramifications in the production process.

The Multi-billion Dollars Revolution

In our title, we have referred to group technology as the multi-billion dollar revolution. Batch manufacturing involves many billions of dollars each year, and group technology can bring about very significant savings in both design and manufacturing.

The wide scale application of group technology is so new that extensive documented figures relating to savings are just now becoming available. There is enough data, however, to provide good indications of the savings that can be expected.

Design Savings

Design retrieval and design standardization cuts design costs by 5 to 10%. These percentages can run somewhat higher - - to 15% - - depending on how organized the company was before implementing group technology.

Manufacturing Savings

The biggest savings from group technology are in manufacturing, rather than in design. This is quite appropriate since, as we pointed out before, the overwhelming portions of total costs are in manufacturing, rather than in design.

Our experience has indicated:

- Savings in set-up time of 40 to 60%.
- A 10 to 30% increase in manufacturing capability, without additional machine tool purchases..
- A 40 to 60% reduction in throughput time and parallel savings in work in process and finished parts storage.

There are still other savings. The standardization of manufacturing processes and the communication, through computerized parts characterization, between manufacturing and design

means that designers can design with manufacturing capabilities in mind.

One can also anticipate a reduction in manufacturing time through the better use of Numerically Controlled machine tools. NC tapes can be generated for families, reducing the number of NC tapes required for individual parts. As a result, it is possible with group technology to use NC machine tools for much smaller lot sizes. We know of one case where the economical lot size was reduced from 25 to 1 or 2.

The use of NC tools for smaller lot sizes reduces production time, lowers scrap rates, and lowers production costs.

In closing, we should point out that group technology systems are not free. There are not only the costs of buying the system, which are relatively small; there are - - also the costs associated with implementing it. A great deal of work is required and the people involved in the implementation must be good at their jobs.

Most of all, there must be a strong management commitment and top management involved in the implementation process. Group technology can bring design and manufacturing personnel together in may new ways. Local interdepartmental differences must be resolved in the process, and this can only be done with top management involvement.

The benefits are well worth the costs, however, as we have attempted to point out. Group technology is a revolution which is only now in its infancy. In the years to come, we expect to see the wide spread use of group technology in the United States and throughout the world. It will be a multi-billion dollar revolution.